REMARKS

This Amendment is made in response to the Final Office Action mailed October 12, 2000, with the term for reply extended three months. Reconsideration and withdrawal of the objections to and rejections of this application are respectfully requested in view of the amendment, remarks and attachments which place the application into condition for allowance or in better condition for appeal.

Claims 6 to 15 are canceled without prejudice, admission, surrender or with any intention of creating any estoppel as to equivalents. Applicants reserve the right to pursue canceled subject matter in a continuation application.

Support for newly presented claims 16 to 25 can be found in the originally filed specification and cancelled claims. No new matter is added.

The Examiner is thanked for withdrawing various objections and rejections in view of the amendment filed July 11, 2000.

It is submitted that these claims are patentably distinct from the references cited in the Office Action, and that these claims are in full compliance with the requirements of 35 U.S.C. §112. The addition of the claims and amendments herein are not made for the purpose of patentability within the meaning of 35 U.S.C. §§ 101, 102, 103 or 112; but rather the additions and amendments are made simply for clarification and to round out the scope of protection to which Applicants are entitled.

Claims 16 to 25 are now pending in this application.

The disclosure is objected to due to various informalities (Office Action, at 2 to 6).

Specifically, the specification is said to lack disclosure concerning the conditions under which the intrinsic viscosities are determined. Applicants respectfully disagree and have already provided, in response to the previous Office Action[1], the DIN standard demonstrating that for a measurement of polyolefin viscosity, decahydronaphthalene is used as a solvent (or in decalin solution) and that temperature of 135^0C is applied (*See* DIN 53728, page 4, ISO 1191-1970). Applicants disagree with the assertion that the specification lacks essential subject matter that somehow lessens the enabling scope of the instant invention. The Federal Circuit applies a skilled artisan standard and inquires as to the knowledge of the skilled artisan at the time of filing of the application. *See In re Epstein*, 32 F.2d 1559, 1564 (Fed. Cir. 1994) ("The time relevant to the level of skill inquiry is when the application was filed[.]"); *see also*, *Graham v. John Deere*, 383 U.S. 1, 17, (1996) (finding that skill level is measured at the time the invention was made). Applicants respectfully assert that a skilled artisan, at the time of filing of the instant application, would readily understand that measurement of the viscosity of polyolefins are routinely determined by such standards and would, in turn, know which standard to use and what experimental conditions to apply. A skilled artisan would, consequently, not be required to perform any undue experimentation in order to practice the instantly claimed invention in general, or to calculate the intrinsic viscosity of the polyolefin in particular. Consequently, the objection is obviated.

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[1] The arguments in which are incorporated herein by reference.

The Office Action further asserts that the specification fails to define the DIN53461 standard and the experimental conditions under which the HDT is determined. In response, attached as Exhibit 1 is an English translation of the DIN 53461 standard which clearly sets out the conditions under which the HDT is determined. As noted above, however, a skilled artisan would, by definition, know how to determine the HDT and know the experimental protocol and conditions necessary to achieve it. Thus, this objection is obviated.

The Office Action also asserts on page 6, claim 15's recitation of crosslinking with metal ions lacks antecedent basis. Claim 15 is cancelled and replaced with new claim 25 to clarify that a polyolefin resin having a cyclic structure further comprising a carboxyl group is cross-linked by metal ions or dienes (*see* specification at page 7, lines 11-13). Consequently, the objection is mooted.

Thus, withdrawal of the of the objections to and reconsideration of the specification and claims are respectfully requested.

Claims 8 to 14 are rejected under 35 U.S.C. §112, second and first paragraphs, (Office Action, at 7 to 16). The Office Action raised several rejections to claims 8, 9, 10, 11, 12, 13 and 14, respectively. These claim rejections will be addressed collectively. In view of cancelled claims 8 to 14 and newly submitted claims 16 to 25, and further in view of the submission of an English translation of the DIN 53461 standard, the rejections based on 35 U.S.C. §112, second and first paragraphs, are obviated. Further, and with respect to the rejection of claims 8-10 and 12 based on an alleged lack of enablement, Applicants disagree with the contention in the Office Action that a change of the DIN standard over time would render the

claims non-enabled. It is well-known that enablement is determined at the time of the filing of a patent application. This rule sets the "state of the art" standard at the filing date, thereby determining the skill-level of one skilled in the art. *See In re Epstein*, 32 F.2d 1559 (Fed. Cir. 1994). Consequently, any hypothetical change of, or revisions to, DIN 53461 would be irrelevant because, at the time of the filing of the instant application, a skilled artisan would readily understand that DIN 53461 could be used to practice the instantly claimed invention. Thus, counter to the assertion on page 13 of the Office Action, undue experimentation would not be required to, *inter alia*, determine the experimental parameters needed to obtain the instant claimed numerical ranges.

In view of the foregoing, reconsideration and withdrawal of the objections to the specification and rejections under 35 U.S.C. §112, second and first paragraphs, and favorable consideration of new claims 16 to 25 are respectfully requested.

Claims 6, 12 and 13 are rejected under 35 U.S.C. §102(b) as being anticipated by Japanese Patent No. 58-149060 ("JP '060"). JP '060 is said to relate to a toner that includes a colorant, carbon black, a charge controlling agent, and a binder resin that has a polyolefin resin with a cyclic structure, polynorborene, and a styrene-acrylate resin. According to the Office Action, JP '060 relates to a toner that is effectively fixed by a heating roller without causing offsetting even when a fixed roller is not fed a releasing solution. (Office Action, at 16-17). Applicants respectfully disagree and in view of cancelled claims 6, 12 and 13 and newly presented claims 16-25, renders this rejection moot.

Specifically, Applicants' invention is directed to, *inter alia*, a toner for developing

an electrostatically charged copier or printer image using a heat roller fixing means, the toner consisting essentially of a binder resin, a colorant and a charge control agent, wherein the binder resin includes a polyolefin resin having a cyclic structure, wherein the polyolefin resin is a copolymer derived from an alpha-olefin, an alicyclic compound having a double bond and, optionally, a diene monomer.

It is respectfully submitted that a two-prong inquiry must be satisfied in order for a Section 102 rejection to stand. First, the cited reference must contain all of the elements of the claimed invention. *See Lewmar Marine Inc. v. Barient Inc.,* 3 U.S.P.Q.2d 1766 (Fed. Cir. 1987). Second, the reference must contain an enabling disclosure. *See Chester v. Miller,* 15 U.S.P.Q.2d 1333, 1336 (Fed. Cir. 1990). A reference contains an enabling disclosure if a person of ordinary skill in the art could have combined the description of the invention in the reference with his own knowledge of the art to have placed himself in possession of the present invention. *See In re Donohue*, 226, U.S.P.Q. 619, 621 (Fed. Cir. 1985).

Applying the law to the instant facts, the reference relied upon by the Office Action does not disclose, suggest or enable Applicants' invention. First, JP '060 does not contain all of the elements of the instant claims. Claim 16, support for which is from cancelled claim 6 and presented to better clarify the scope of Applicants' invention, provides for a compound wherein the polyolefin resin is a copolymer derived from a cyclic olefin copolymer. JP '060 does not teach such a toner. Thus, JP '060 does not read on the instant claims. Second, JP '060 does not enable Applicants' invention wherein the polyolefin resin is a copolymer derived from a cyclic olefin copolymer. Thus, the Section 102 rejection should be obviated.

Consequently, reconsideration and withdrawal of the Section 102 rejections based on JP '060 is respectfully requested.

Claims 6 and 12-14 are rejected under 35 U.S.C. §103(a) as being allegedly unpatentable over Sacripante, U.S. Patent No. 5,324,616 (the "'616 patent") as combined with the Handbook of Imaging Materials, page 169. The '616 patent is said to relate to a heat fusible encapsulated toner that includes a core with a colorant and a binder resin. The binder resin is said to further include a polyolefin with a cyclic structure, such as polynorborene. The Office Action further asserts that the '616 patent further relates to a polyolefin with a cyclic structure that can be obtained by polymerizing "hydroxy nornbornene" [sic], thus meeting the limitation of claim 14. However, the Office Action admits, the '616 patent does not disclose a toner comprises a charge controlling agent. But, the use of a charge controlling agent is said to be well-known in the art since the Handbook of Imaging Materials, page 169 relates to an addition of charge control additives to toners when the pigment blended into the polymer resin does not give an adequate charge level or rate of charging. The Handbook of Imaging Materials is also said to disclose a number of known charge control agent, such as nigrosine, and metal complexes that are effective at giving the toner a positive or negative charge. Accordingly, the Office Action concludes that it would have been obvious to one skilled in the art to add a charge control agent (in view of the Handbook of Imaging Materials) to the toner in the '616 patent. (Office Action, at 17 to 19).

Claims 6, 7, 10 and 12-15 are rejected under 35 U.S.C. §103(a) as being unpatentable over Japanese Patent 2-184864 ("JP '864" patent) combined with page 13 of Grant

& Hackh's Chemical Dictionary. JP '864 is said to relate to a toner having a colorant and a binder resin that has a polyolefin resin with a cyclic structure, a cyclopentadiene polymer. The toner in JP '864 is said to be capable of being fixed by ultraviolet-cure. The Office Action admits, however, that JP '864 does not exemplify a toner that comprises a charge controlling agent, but asserts that JP '864 relates to a polarity-controlling agent that can be incorporated in its toner. Grant & Hackh's Chemical Dictionary is relied upon as allegedly disclosing that methacrylic acid is an alpha olefin acid (Office Action, at 20 to 21). Finally, claims 6, 7 and 10-13 are rejected 35 U.S.C. §103(a) as being unpatentable over U.S. 5,817,843 to Masuda ("'843 patent") combined with U.S. 5,741,617 to Inaba ("'617 patent") and U.S. 5,179,171 to Minami ("'171 patent). The Office Action asserts that the '843 patent relates to a toner having a colorant, a quinizarin dye and a binder resin. However, the '843 patent does not identify charge control agents nor does it disclose that the binder resin is a polyolefin resin. The '617 patent is relied upon as identifying alleged charge control agents. The '171 patent is relied upon as allegedly relating to a random copolymer resin with a cyclic structure. (Office Action, at 23 to 25).

These Section 103 rejections will be addressed collectively. It is submitted in view of the claim amendments and the remarks herewith, reconsideration and withdrawal of these rejections based on Section 103 are respectfully requested.

The present invention teaches a toner for developing an electrostatically charged image of a heat roller type copier or printer, the toner according to the present invention comprising a binder resin, a colorant and a charge control agent, wherein the binder resin includes a polyolefin resin having a cyclic structure. The polyolefin resin in accordance with the

present invention is a copolymer derived from an alpha-olefin, an alicyclic compound having a double bond and, optionally, a diene monomer. The instant invention is also directed to a toner for developing an electrostatically charged copier or printer image using a heat roller fixing means, the toner comprising a binder resin, a colorant and a charge control agent. The binder resin in accordance with the present invention includes a polyolefin resin having a cyclic structure having (i) a low-viscosity resin with a number average molecular weight (Mn) of about 1000 to about 7500 and a weight average molecular weight (Mw) of about 1,000 to about 15,000, as measured by GPC, an intrinsic viscosity (i.v.) of less than about 0.25 dl/g, and a heat distortion temperature (HDT) by DIN53461-B of lower than about 70^0C; and (ii) a high-viscosity resin having a number average molecular weight of at least about 7,500 and a weight average molecular weight of at least about 15,000, as measured by GPC, an i.v. of about 0.25 dl/g or more, and an HDT of about 70^0C or higher. The polyolefin resin of the present invention is a copolymer derived from an alpha-olefin, an alicyclic compound having a double bond and, optionally, a diene monomer.

The toner for developing an electrostatically charged image according to the present invention is excellent in fixability, light transmission, and anti-toner spent properties, giving a sharp, high quality image. The toner in accordance with the present invention can apply to any of a dry one-component magnetic toner, a dry one-component nonmagnetic toner, a dry two-component toner and a liquid toner. The toner in accordance with the present invention also exhibits marked effects particularly when used in a color toner.

The '843 patent relates to a quinizarin compounds for dyes. The '617 patent relates to toners having a binder resin, a colorant and a wax composition. The '171 patent relates to a random copolymer and synthetic waxes.

As for the Section 103 rejections, it is urged that JP '616, JP '864, the '843 patent, the '617 patent and the '171 patent, either alone or in any combination, fails to disclose, suggest, or motivate a skilled artisan to practice the presently claimed invention. In order to ground an obviousness rejection, there must be some teaching which would have provided the necessary incentive or motivation for modifying the reference's teaching. *In re Laskowski*, 12 U.S.P.Q. 2d 1397, 1399 (Fed. Cir. 1989); *In re Obukowitz*, 27 U.S.P.Q. 2d 1063 (B.P.A.I. 1993). Further, "obvious to try" is not the standard under 35 U.S.C. §103. *In re Fine,* 5 U.S.P.Q. 2d 1596, 1599 (Fed. Cir. 1988). And, as stated by the Court in *In re Fritch*, 23 U.S.P.Q. 2d 1780, 1783-1784 (Fed. Cir. 1992): "The mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious unless the prior art suggests the desirability of the modification." Also, the Examiner is respectfully reminded that for the Section 103 rejection to be proper, both the suggestion of the claimed invention and the expectation of success must be founded in the prior art, and not Applicants' disclosure. *In re Dow*, 5 U.S.P.Q.2d 1529, 1531 (Fed. Cir. 1988).

In each of the references relied upon in the Office Action, the requisite suggestion or motivation is lacking.

Further, and with reference to the '843 patent, Applicants assert that the reference is inappropriate as evidence of obviousness. First, a skilled artisan would not be motivated to

practice the instantly claimed cyclic olefin copolymer from the '843 patent's alleged disclosure of an alicyclic hydrocarbon resin. A skilled artisan would consider a cyclic olefin copolymer to be distinguishable from an alicyclic hydrocarbon. Second, even if the '843 patent discloses that a binder resin can be any binder resin known in the art (Office Action, at 24), that still does not satisfy the legal standard promulgated by the Federal Circuit. It is well-known that a genus disclosed in a reference does not render obvious a species, absent a suggestion or motivation that would disclose to a skilled artisan the desirability of practicing the species. *See In re Jones*, 958 F.2d 347 (Fed. Cir. 1992). Such a suggestion or motivation is lacking because the '843 patent, *inter alia*, fails to disclose, motivate, teach or suggest the instantly claimed cyclic olefin copolymers.

Further, neither the '617 or '171 patents remedy the inherent deficiencies of the '843 patent. To wit, both the '617 and '171 patents relate to waxes. Specifically, the '617 patent is directed to "toner particles contain[ing] inside the particle a wax composition containing ester wax" (col. 4, lines 32-34). Similarly, the '171 patent is directed to "synthetic waxes" applicable to a laundry list of uses (col. 15, line 53 to col. 16, line 5). The present invention, on the other hand, is not directed to waxes. Indeed, the '617 and '171 patents teach away from Applicants' invention because a skilled artisan would readily know that when a wax is used as a binder for a toner, adherence of the toner to the substrate (such as paper) is achieved by cold pressure fixing. By contrast, Applicants' invention is directed to a toner for developing an electrostatically charged copier or printer image using a heat roller fixing means. As no combination of the '843, '617 and '171 patents could lead a skilled artisan to achieve the

instantly claimed invention, the rejection is fatally defective.

Accordingly, reconsideration and withdrawal of the Section 103 rejections based on JP '616, JP '864, and the '843, '617 and '171 patents, alone or in any combination, are respectfully requested.

Pursuant to 37 C.F.R. §§1.136(a) and 1.17(a)(3), Applicants hereby request that the term for reply to the October 12, 2000 Office Action be extended three months, i.e., up to and including April 12, 2001. A check for $870.00 is enclosed herewith.

Any additional fee occasioned by this paper, including with respect to the claim amendments herewith and the petition for extension of time herein accompanying this paper, or any overpayment in those fees, may be charged or credited to Deposit Account No. 50-0320.

In view of the amendments, remarks and attachment herewith, the present application is in condition for allowance. Early and favorable reconsideration and prompt issuance of a Notice of Allowance are earnestly solicited.

If any issue remains as an impediment to allowance, an interview is respectfully urged and the Examiner is further respectfully requested to contact the undersigned by telephone to arrange a mutually convenient time and manner for the interview.

Respectfully submitted,

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AFFIDAVIT OF ACCURACY

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) ss.:
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I, the undersigned, being duly sworn, depose and state:

I am qualified to translate from the German language into the English language by virtue of being thoroughly conversant with these languages and, furthermore, having translated professionally from German into English for more than 8 years;

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this 12th day of April, 2001.

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[Translation from German]

January 1987

	Testing of Plastics **Determination of Heat Deflection Temperature Under Load**	**DIN** 53 461

Replaces version issued 09/69

See Notes for relationship to international draft standard ISO/DIS 75 – 1984 issued by the International Organization for Standardization (ISO).

1 Application and Purpose

1.1 The purpose of testing is to determine the heat deflection temperature of test bodies of specific dimensions that are subjected to temperature increases under constant bending load in a heat transfer liquid.

1.2 This Standard distinguishes among 3 different methods for determining the heat deflection temperature, which differ in the bending load applied (see Section 3.2 and Table 1).

Table 1

Method	Bending Stress N/mm² ± 2.5%
A	1.80
B	0.45
C	5.0

The method to be used for testing must be agreed upon in each individual case or defined in product standards.

Note: Method C is recommended for heat-resistant plastics whose heat deflection temperature according to Methods A and B is higher than the maximum operating temperature of the heat transfer medium.

1.3 The test can be used for plastics that are dimensionally stable up to a temperature of 27°C.

1.4 The values obtained in accordance with this Standard can be used for evaluating the behavior of plastics under bending load at temperatures above room temperature. It is only permissible to directly apply the test results to specific applications if the conditions regarding time, temperature and bending stress are similar to the conditions specified in this Standard.

The values obtained do not represent the maximum service temperatures, as these temperatures are a function of the variable influences mentioned above.

1.5 If no heat transfer liquid conforming to the requirements in Section 3.3 can be found for the plastic to be tested, the test method specified in this Standard cannot be used[1].

[1] For use of air as the heat transfer medium, see DIN 53 462.

Note: If Method C (see Section 3.2) of the present Standard does not produce reasonable results for composite materials, such as combined pressboard per DIN 7739 Part 2, laminated plastics and reinforced plastics, please refer to "Testing of dimensional stability under heat" per DIN 53 462. Dimensional stability under heat of rigid cellular materials is tested according to DIN 53 424.

2 Definition of Terms

2.1 Dimensional Stability under Heat

Dimensional stability under heat is the capacity of a test body to largely maintain its shape up to a specific temperature under a specific static load. In this Standard, dimensional stability under heat is characterized by the heat deflection temperature.

2.2 Heat Deflection Temperature

The heat deflection temperature HDT per this Standard is the temperature at which the bending test body, which is supported on both sides in a heat transfer liquid and subjected to uniform, continuous heating, has attained a defined deflection — corresponding to an outer fiber strain of approximately 0.2% — under a specific centrally applied force.

0.2% —

Note: Test results are the heat deflection temperatures HDT/A, HDT/B, and HDT/C.

3 Test Apparatus

3.1 Test Set-up

The test set-up should correspond in essential respects to Figure 1 and comply with the requirements described in Sections 3.2 through 3.6.

3.2 Bending Device

The bending device consists of two supports and one bending die made of metal. The edges have a radius of curvature of (3 ± 0.2) mm. The support span is (100 ± 2) mm. It must be possible to apply the force in the center of the support span, perpendicular to the orientation of the test body, by means of the bending die. The vertical connecting pieces between the supports, and the cover that the deflection measuring device rests upon, must be made of a material that has the same coefficient of linear expansion as the bending die.

Note: If these parts of the test apparatus do not have the same coefficient of linear expansion, the differing changes in length of these parts produce a measurement error when the deflection of the test body is measured. The test apparatus should be tested with the aid of a rigid test body made of a material with a low coefficient of linear expansion in the temperature range in question. (Test bodies made of steel with a Ni content of 38% by weight, corresponding to types D1 and D1a per DIN 41 301, or made of borosilicate glass, have proven useful for this purpose.) If the measurement resulting from this test is ± 0.01 mm or larger, it must be added or subtracted when determining deflection per Section 5.4.

To produce the force, weights which apply a bending stress of 1.80 N/mm² (method A), 0.45 N/mm² (method B), or 5.0 N/mm² (method C) (see also Table 1) are used. When calculating the mass of the weights, it is necessary to account for the weight of the bending die and, if necessary, the measurement force of the measuring device used to measure deflection.

A set of a variety of weights is recommended to make it possible to set the necessary bending force (limit deviations ± 2.5%).

Note: In some configuration types of the test apparatus, the spring force of the dial indicator acts upward. The weights must then be heavier by an amount corresponding to this spring force. They must be lighter by a corresponding amount if the spring force of the dial indicator acts downward.

Since the spring force is a function of the measurement distance in some dial indicators, the force must be measured in the section of the measurement distance that is used.

The force F in N is calculated with the following equation:

$$F = (2\, a \cdot b \cdot h^2) / (3\, L_s)$$

where:

a is the greatest bending stress in the test body for methods A, B, and C in N/mm²

b is the width of the test body in mm

h is the height of the test body in mm

L_s is the support span in mm.

3.3 Immersion Bath

A suitable heat transfer liquid in which the test body can be immersed must be used for the immersion bath. The bath must have a stirring device. It must be possible to raise the bath temperature at a steady rate of 2 K/min (see Section 5.4).

A heat transfer liquid should be used that is stable at the temperatures employed, and which does not influence the properties of the test body.

Note: Polyglycol, paraffin oil and silicone oil have proven suitable in many instances; see the relevant standards for the plastic product.

3.4 Temperature Measurement Device

The temperatures are measured with 2 temperature measurement devices; tolerances G = 0.5 K. The devices must extend to the depth for which the tolerances apply, but no less than 50 mm deep.

3.5 Deflection Measuring Device

The measurement device must be capable of determining the deflection of the test body to 0.01 mm.

3.6 Linear Measurement Device

The linear measurement device must be capable of determining the height and width of the test body to 0.1 mm.

[Labels for diagram, page 2:]

Dimensions in mm

Cross-section A - B

Cross-section C - D

weight

deflection measuring device

thermometer

cover

immersion bath

bending block

test body

support

Figure 1. Test set-up for determining heat deflection temperatures (example configuration)

4 Test Bodies

4.1 Shape and Fabrication

4.1.1 The test bodies have a length *l* of at least 110 mm, a width *b* of 3.0 to 4.2 mm, and a height *h* of 9.8 to 15.0 mm, with the exception of test bodies made of slab products, whose width *b* may be between 3 and 13 mm. The test bodies should be produced or sampled in such a manner that the force of pressure used in their fabrication has acted on the surface $A = l \cdot h$.

Test body dimensions deviating from these must be specified in the applicable standards for the plastic product or must be agreed between supplier and customer.

Note: The heat deflection temperature may increase by up to 4 K with increasing width and height of the test body in the ranges specified here.

4.1.2 If not otherwise specified in the relevant standards for the plastic product, or not otherwise agreed between supplier and customer, test bodies of thermosetting molding materials are produced according to DIN 53 451, and test bodies of thermoplastic materials are produced either through injection molding[2] or through compression molding[3] while taking into account the conditions specified in the relevant standards regarding molding materials.

The test results depend upon the manufacturing conditions of the test body and upon the pretreatment (for example, drying, temperature treatment, conditioning). Hence, precise specifications for these conditions are necessary in arbitrational analysis.

4.2 Quantity

At least 2 test bodies from each sampled product must be tested.

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[2] See DIN 16 770 Part 2
[3] See DIN 16 770 Part 1

4.3 Pretreatment

The test bodies must be pretreated in accordance with the relevant standards for the molding compound or in accordance with the agreements between supplier and customer.

5 Procedure

5.1 Prior to testing, the width *b* and the height *h* are measured to 0.1 mm in the center of the test body.

5.2 The test body is placed on end on the supports (see Fig. 1). The temperature measurement devices are inserted in such a way that they extend to within 2 mm of, but do not touch, the test body in the vicinity of the pressure die. At the start of each test, the bath temperature should be 20 to 23°C unless preliminary testing has demonstrated that a different starting temperature does not cause any errors with the product under test.

5.3 The force calculated for methods A, B or C per Section 3.2 is applied to the test body.

After the load has been maintained for 5 minutes, the deflection measuring device is set to zero and the heat is turned on. The 5-minute waiting period can be omitted if the test body deflects less than 0.02 mm in this period of time.

Note: The purpose of the 5-minute waiting period is to partially compensate for the creep exhibited by a variety of materials at room temperature when they are subjected to the prescribed bending stress. The creep that takes place within the first 5 minutes usually constitutes the majority of creep occurring in the first 30 minutes.

5.4 The temperature of the bath is steadily raised by 2 K/min. There must never, at any time during the test, be a difference of more than 1 K between the specified and actual temperatures. The temperature at which the test body has achieved the deflection specified in the following table is the heat deflection temperature.

Table 2

Height *h* of the Test Body mm	Test Body Deflection mm
9.8 to 9.9	0.33
10.0 to 10.3	0.32
10.4 to 10.6	0.31
10.7 to 10.9	0.30
11.0 to 11.4	0.29
11.5 to 11.9	0.28
12.0 to 12.3	0.27
12.4 to 12.7	0.26
12.8 to 13.2	0.25
13.3 to 13.7	0.24
13.6 to 14.1	0.23
14.2 to 14.6	0.22
14.7 to 15.0	0.21

5.5 If the heat deflection temperatures of the two test bodies differ from one another by more than 2 K[4], additional tests must be performed, and the individual values must be given as the results.

In the case of semicrystalline thermoplastics[4] whose glass transition temperature lies between the starting temperature and the heat deflection temperature, it is possible that the deflection temperature function in the range of required deflection defined in Section 5.4 can be sufficiently flat in one of the methods defined in Section 3.2 (e.g., method B) that reproducibility and comparability[5] of the test method become very uncertain. In these cases, the test can only be performed with one of the other methods (e.g. method A or C) described in Section 3.2.

6 Evaluation

The average, rounded to 1 K, of the individual values is the heat deflection temperature HDT/A, HDT/B or HDT/C.

7 Test Report

The test report must make reference to this Standard and include the following information:

a) Width *b* and height *h* of the test body to an accuracy of 0.1 mm

b) Manufacturing conditions of the test body

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[4] ISO/DIS 75 – 1984 allows deviations of up to 5 K for semicrystalline thermoplastics. This provision was not adopted in the present Standard for the reasons described in Section 5.5.

[5] For definitions of reproducibility and comparability, see DIN 1319 Part 3.

c) Pretreatment of the test body; if necessary, description of the state

d) Heat transfer liquid used

e) Heat deflection temperature HDT in °C, rounded to whole numbers, and the Method used (A, B or C as described in Section 3.2). For example, if Method A resulted in a temperature of 82°C: HDT/A (DIN 53 461) = 82°C

– Individual values if more than two measurements were necessary per Section 5.5

f) External changes in the test body, if applicable

g) Any conditions deviating from this Standard

h) Test date.

Cited Standards

DIN 1319 Part 3	Basic concepts in metrology; Terminology relating to the uncertainty of measurement and the assessment of measuring instruments and measuring equipment
DIN 7739 Part 2	Laminated products; Combined pressboard for electrical insulation: types
DIN 16 770 Part 1	Testing of plastics; Preparation of specimens of thermoplastic molding materials by compression molding
DIN 16 770 Part 2	Testing of plastics; Preparation of specimens of thermoplastic molding materials by injection molding

DIN 41 301	Magnetic steel sheets; magnetic materials for transformers
DIN 53 424	Testing of rigid cellular materials; Determination of dimensional stability at elevated temperatures with flexural load and with compressive load
DIN 53 462	Testing of plastics; Martens method of determining the temperature of deflection under a bending stress
DIN 53 451	Plastics; Directions for preparing test specimens of thermosetting molding materials
ISO/DIS 75 – 1984	E: Plastics and ebonite; determination of temperature of deflection under load F: Matieres plastiques et ebonite; détermination de la temperature de fléchissement sous charge D: Kunststoffe; Bestimmung der Temperatur bei bestimmter Durchbiegung under Last

Additional Standards

DIN 53 487	Testing of plastics; determining the temperature of deflection as a function of temperature

Prior Versions

DIN 53 461: 06/61, 09/69

Revisions

The following revisions were made from the September 1969 version:

- Adoption of Method C with higher bending stress
- Adoption of new symbol — HDT — for test quantity
- Standard adapted to the international draft standard ISO/DIS 75 – 1984 (see also Notes)

Notes

The content of this Standard is consistent with ISO/DIS 75 – 1984.

This Standard deviates from ISO/DIS 75 – 1984 in the following areas:

1. No greater deviation among individual measured values is permitted for semicrystalline thermoplastics (See Section 5.5).
2. In contrast to ISO/DIS 75 – 1984, Method C with a higher bending stress was additionally adopted here to make it possible to test heat-resistant plastics, filled plastics, and reinforced plastics.

This Standard is limited to the comparison of dimensional stability under heat of plastics by means of a heat deflection temperature HDT/A, HDT/B or HDT/C measured under comparable conditions. The dependence of the heat deflection temperature on the size of the bending load can differ widely, depending on the type of plastic. Knowledge of the functional relationships can be essential in the selection of materials for applications with specific loads, and can be determined according to DIN 53 487 for example.

As part of the efforts to unify the test body, the ISO bar, 80 mm × 10 mm × 4 mm, was also tested for determination of the heat deflection temperature. As in the bending test per DIN 53 452, the ISO bar is placed flat on the two supports with a support span of 64 mm, and subjected to loading in the center. Preliminary comparison tests have demonstrated that the same heat deflection temperatures are achieved with the previous test body (placed on end on the two supports with a support span of 100 mm) as with the ISO bar.

International Patent Classification

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